DAY-ROOSTS OF FEMALE LONG-EARED MYOTIS IN WESTERN OREGON

DAVID L. WALDIEN,[1,2] Department of Forest Science, Oregon State University, Corvallis, OR 97331, USA
JOHN P. HAYES, Department of Forest Science, Oregon State University, Corvallis, OR 97331, USA
EDWARD B. ARNETT, Weyerhaeuser Company, P.O. Box 275, Springfield, OR 97478, USA

Abstract: Roosts are a critical habitat component for bats and may influence their survival and fitness. We used radiotelemetry to investigate characteristics of day-roosts of female long-eared myotis (*Myotis evotis*) in watersheds characterized by different forest conditions and the spatial relationships between day-roosts and available water. We tracked 21 bats to 73 roosts (n = 102 occasions) from June to August 1996 and 1997 on the western slope of the Cascade Mountains, Oregon. Bats primarily used conifer stumps as day-roosts in watersheds dominated by younger forests and used conifer snags, and to a lesser extent conifer stumps, in watersheds with greater proportions of older forests. Individual long-eared myotis used different types of structures as day-roosts, and type of structure used did not differ with reproductive condition. Day-roosts were primarily located in upslope habitat and averaged 0.59 ± 0.03 km from available water and 0.66 ± 0.02 km from capture sites. Roosts were not located closer to available water than random points, but were closer than random points to captures sites. Conifer snags used as day-roosts averaged 34 ± 5 m in height and 93 ± 12 cm diameter at breast height (dbh); snags in intermediate stages of decay had highest use. Use of conifer snags was positively associated with the number of snags within 20 m and negatively associated with distance from stand edge. Conifer stumps used as day-roosts averaged 133 ± 9 cm in height and 59 ± 4 cm dbh. Western hemlock and Douglas-fir stumps were used more often than western redcedar stumps as day-roosts. Odds of a stump being used as a day-roost increased with increasing height of the stump (downhill side) and whether it was situated in a gap in vegetation. We contend that management of day-roosts for forest-dwelling bats should focus on maintaining large conifer snags across landscapes through space and time. In landscapes where there are relatively few large conifer snags, stumps appear to provide important, but ephemeral, roosts for long-eared myotis.

JOURNAL OF WILDLIFE MANAGEMENT 64(3):785–796

Key words: day-roosts, long-eared myotis, *Myotis evotis,* Oregon, snags, spatial patterns, stumps, water.

Selection of day-roosts by forest-dwelling bats in the Pacific Northwest is poorly understood (Brigham and Barclay 1996) and data are limited for many species. Roosts are a critical habitat component for bats (Kunz 1982), and may influence their survival and fitness (Vonhof and Barclay 1996). Selection of day-roosts may be influenced by forest structure (Crampton and Barclay 1998) and the proximity of day-roosts to other important resources (e.g., alternate day-roosts, night-roosts, available water, and hibernacula). Understanding factors that influence selection of day-roosts by bats is important to help guide future resource management decisions that may influence the availability, distribution, and quality of potential day-roosts in an area.

Wildlife respond to structural characteristics of forests (Hayes et al. 1997). Although use of large snags as day-roosts by bats has been well documented in older forests in many regions of North America (Campbell et al. 1996, Vonhof and Barclay 1996, Brigham et al. 1997, Betts 1998, Ormsbee and McComb 1998, Rabe et al. 1998), information on how selection of roost structures may differ by forest type for a species is limited. Results from a number of studies indicate that roost-site selection can vary with forest type. For example, big brown bats (*Eptesicus fuscus*) used cavities in dead ponderosa pine (*Pinus ponderosa*) trees as day-roosts in British Columbia (Brigham 1991), man-made structures in Ontario (Brigham 1991), and exclusively roosted in cavities of trembling aspen (*Populus tremuloides*) in Saskatchewan, although cavities were also available in conifers (Kalcounis and Brigham 1998). Silver-haired bats (*Lasionycteris noctivagans*) have been documented to roost primarily in conifer snags in coniferous forests in western North America (Campbell et al. 1996, Mattson et al. 1996, Von-

[1] Present address: Department of Fisheries and Wildlife, Oregon State University, Corvallis, OR 97331, USA.
[2] E-mail: David.Waldien@orst.edu

hof and Barclay 1996, Betts 1998), but used peach-leaved willow (*Salix amygdaloides*) and green ash (*Fraxinus pennsylvanica*) in Manitoba (Barclay et al. 1988), and trembling aspen and *Populus* sp. in Alberta (Crampton and Barclay 1998). In addition to using different types of roosts in forests that differ structurally, selection of roosts also may be influenced by their availability, which is sometimes related to age or structure of forest stands (Crampton and Barclay 1998, Jung et al. 1999). Landscapes intensively managed for timber production are often characterized by younger forests with low densities of large dead or decadent conifers (Ohmann et al. 1994). It is unclear how availability of dead conifers in these landscapes influence patterns of use by bats as data on use of day-roosts in intensively managed forest landscapes is virtually nonexistent for most species of bats.

Spatial relationships of day-roosts and available water are also poorly understood, particularly in the Pacific Northwest. Open bodies of water and riparian areas often function as foraging areas for bats (Caire et al. 1984, Lunde and Harestad 1986, Thomas 1988, Barclay 1991, Brigham et al. 1992, Adams 1997) because they provide a source of water for drinking and an abundant prey base. Foraging bouts can account for the largest proportion of a bats daily energy budget (Kurta et al. 1989), and roosting close to areas with available water and adequate prey may minimize energetic costs of commuting between roosts and activity areas (Tuttle 1976). Increased understanding of the juxtaposition of day-roosts to available water would enable managers to better manage for roosts of bats in landscapes.

The lack of information concerning habitat requirements of long-eared myotis, such as the selection of maternity roosts, has led to the designation of long-eared myotis as a species of concern by the Oregon Department of Fish and Wildlife (Marshall et al. 1996) and U.S. Fish and Wildlife Service (Forest Ecosystem Management Assessment Team 1993). Limited research on long-eared myotis has examined characteristics of conifer stumps used for roosting (Vonhof and Barclay 1997). Other studies of day-roosts of long-eared myotis have combined data for multiple species (Vonhof and Barclay 1996, Rabe et al. 1998); this approach has resulted in small numbers of bats of this species tagged and relatively few roost structures identified. Long-eared myotis are thought to be associated with forested areas, although they also occur in other habitats (Manning and Jones 1989, Verts and Carraway 1998, Bogan 1999). Long-eared myotis use a variety of roost structures, including crevices and cavities in trees, snags, conifer stumps in clearcuts, and rock outcrops, as well as caves, mines, and man-made structures (Christy and West 1993; Vonhof and Barclay 1996, 1997; Rabe et al. 1998).

Our objectives were to provide information about selection of day-roosts by female long-eared myotis and to determine if use of day-roosts differed among watersheds that were characterized by different forest conditions. We tested whether characteristics of day-roosts of long-eared myotis differed from available structures and if roosts were closer than random points to available water. We also tested if reproductive condition of female long-eared myotis influenced the type of structure used and if different types of roosts were used in different watersheds. Increased understanding of factors that influence selection of day-roosts of forest-dwelling bats would enhance abilities to manage forests in a manner that provides for the habitat needs of long-eared myotis and other species of bats.

STUDY AREA

We conducted the study on the west slope of the Cascades in Lane County, Oregon, between 44°30′ and 43°58′N latitude and 123°50′ and 122°30′W longitude. This area is characterized by a relatively mild climate with average minimum temperatures of −2 to −5°C in January and average maximum temperatures of 24 to 29°C in July (Franklin and Dyrness 1973). Study sites were within the *Tsuga heterophylla* zone (Franklin and Dyrness 1973) and ranged from 350 to 700 m in elevation.

The study area encompasses a diversity of habitats in 3 major drainage systems: Fall Creek, Little Fall Creek, and the South McKenzie River area. Douglas-fir (*Pseudotsuga menziesii*) is the dominant overstory species in all 3 areas; western hemlock (*Tsuga heterophylla*) and western redcedar (*Thuja plicata*) are minor components in many forest stands. Douglas-fir is the primary species selected to regenerate a stand following harvest. The Fall Creek watershed is generally characterized by large areas of older forests (>80 yr) resulting from a history of relatively little timber harvest and from implementation of the Northwest Forest Plan (U.S. Forest Service and U.S. Bureau of Land Management 1994). The Little Fall Creek watershed and the South McKenzie River area are generally dominated by younger forests (<80 yr) resulting from a history of high-yield timber management on private lands; relatively small areas of older forests remain.

METHODS

Capture and Radiotelemetry

We captured bats with mist nets, harp traps, hoop nets (Kunz and Kurta 1988:1–29), and H-nets (Waldien and Hayes 1999) under bridges used as night-roosts and over ponds and streams from June through August 1996 and 1997. We generally initiated capture efforts at sunset and continued for 3 to 4 hr. Captured bats were identified to species, sex, age class (adult or juvenile; Anthony 1988:47–58), and reproductive condition (Racey 1988:31–46).

We attached a 0.51 g radiotransmitter (model LB2, Holohil Systems, Carp, Ontario, Canada) to 21 adult female long-eared myotis at 5 capture sites. We trimmed a small patch of fur from between the scapulae and glued the transmitter to the trimmed area using Skin-Bond (Smith and Nephew United, Largo, Florida, USA). Transmitters were held in place for 1 to 2 min and the bat was retained in a container for an additional 20 to 30 min to allow the adhesive to set. Instrumented bats were released at the capture site within 1 hour of capture. We attached transmitters only to bats >6.5 g in body mass and to females that were not in a late stage of pregnancy; transmitters were 5.7 to 7.7% of body mass of the bat to minimize the impact of transmitters on behavior (Aldridge and Brigham 1988). The range of relative weights of transmitters used in our study were comparable to those of other studies (Adam et al. 1994, Campbell et al. 1996, Vonhof and Barclay 1996, Wethington et al. 1996, Brigham et al. 1997, Ormsbee and McComb 1998) and instrumented bats did not appear to have difficulty flying and did not exhibit unusual behavior when released.

We used TRX-1000S Wildlife Materials (Wildlife Materials, Carbondale, Illinois, USA) and TR-2 Telonics (Telonics, Telemetry-Electronic Consultants, Mesa, Arizona, USA) receivers and hand-held 4- and 6-element yagi antennas to track bats to roost structures. We monitored radiosignals and roosts at dusk to confirm use of structures as day-roosts. We did not use structures from which we did not detect an instrumented bat leaving in our analyses; although this may have eliminated structures used as day-roosts where a bat shed its transmitter, it prevented misclassification of structures where transmitters had been shed by bats in night-roosts or while flying over a structure. All roosts were located using a geographical positioning system (Trimble Navigation, Sunnyvale, California, USA) and locations were imported into a geographical information system (GIS, ArcInfo, Environmental Systems Research Institute, Redlands, California, USA).

Habitat Sampling

We used GIS to define available habitat at each of 5 capture sites. Five polygons of available habitat were defined by combining 2.4-km radius circles circumscribing each day-roost of all bats captured at the same capture site. We delineated the area in which a bat may be expected to select a roost based on the maximum distance (2.4 km) any instrumented bat was detected from a day-roost (Waldien 1998). We contend that our approach of using the maximum distance any female long-eared myotis was observed from a day-roost provides a realistic approximation of the area available for a bat to roost and was preferable to approaches previously used in similar studies such as arbitrarily selecting a distance around the capture site or day-roost, defining the area based on topography and stand conditions, or only upon locations of day-roosts.

We used GIS to randomly select 50 points in each of the 5 polygons of available habitat to evaluate selection of roosts for stand condition, and proximity to streams, available water, and capture sites. We classified forest stands with day-roosts or random points as 0–12, 13–35, 36–80, or >80 years of age. Streams were classified as small (average annual flow $\leq$0.04 m^3), medium (average annual flow >0.04 m^3 and <0.2 m^3), or large (average annual flow $\geq$0.2 m^3; Lorensen et al. 1994). We defined available water as medium and large streams and ponds; capture efforts and observations of bats at ponds and streams in the study area suggests that this designation roughly corresponds to open bodies of water from which bats can drink.

We defined conifer snags as dead or living conifers with areas of decay, and defined conifer stumps as trees cut to a height of ≤3 m; these 2 types of structures represented the majority of roosts used by female long-eared myotis. To compare used and random structures (conifer snags and stumps), we randomly located 6 points in each stand in which a conifer snag or stump was used as a day-roost by female long-eared myotis. We delineated forest stands based on vegetative composition and topographic features; boundaries of stands were generally consistent with management boundaries. In the field, we identified the structure nearest to the random point that was the same type of structure as the roost used in that stand (either a conifer snag or stump). We did not identify random structures for the other types of roost structures (i.e., conifer snags in stands <36 yr old, live conifer trees with no obvious structural defects, logs, or hardwood trees and snags) due to small sample sizes.

We recorded characteristics of day-roosts, random structures (snags or stumps), and surrounding habitats. Each variable was categorized as structural (pertaining to the roost structure) or plot (pertaining to forest conditions around the structure); variables that did not relate to either the structure or plot categories as described above were classified as miscellaneous.

Structural Category.—Conifer snags were identified to species and classified according to level of decay (modified from Bull et al. 1997). Class 1 included live trees with structural defects and recently dead trees with limited decay and most limbs and needles present. Class 2 included dead trees in intermediate stages of decay, often with a portion of the bole broken and variable amounts of missing branches and bark. Class 3 snags included dead, remnant structures (<3 m tall), generally with few branches and little bark remaining. For Class 1 and 2 snags, we noted if the top was intact and noted its height relative to the adjacent canopy. We measured height using a clinometer and dbh using a D-tape, and estimated the percentage of bark and proportion of crown remaining.

Conifer stumps were identified to species and classified according to level of decay. Class 1 included new stumps (cut within the yr) with minimal decay and minimal exfoliation of the bark; class 2 stumps were >1 year old, were generally solid, and had variable levels of decay and exfoliation of bark; and class 3 stumps were >1 year old, had little bark remaining, and were soft due to extensive decay. We estimated percentage of bark remaining on the stump and mean bark thickness (based on 4 measurements; uphill, downhill, left, and right sides), and measured diameter of the top and height of the stump on the uphill and downhill side. We also measured aspect of roost crevices, thickness of bark, and width, depth, and height of the roost entrance.

Plot Category.—For conifer snags, we tallied the number of trees and snags by decay class within concentric plots of 5, 10, and 20 m radius. We measured distance to the nearest tree or snag on the uphill and downhill side that was greater than the structure in height on the slope (not absolute height). We estimated accessibility of the lower (0–8 m), middle (8–16 m), and upper (>16 m) bole of snags by estimating the percentage of the snag obscured by vegetation within 5 m of the bole in 90° arcs on the uphill, downhill, left, and right sides. Canopy cover was measured from aerial photographs at 20- and 50-m radius plots.

For conifer stumps, we tallied the number of small logs (minimum diam between 10 and 50 cm) with any portion occurring within 1- and 5-m-radius concentric plots. Stumps, saplings (trees having a dbh <10 cm), and large logs (minimum diam >50 cm) within 1-, 5-, and 10-m radius concentric plots were counted. We also counted the number of large logs and total number of trees (dbh >10 cm) within 20 m of the stump. Two to 3 observers independently estimated accessibility to stumps based on the degree that each stump was surrounded by or covered with vegetation, logs, or slash within 5 m of the bole in 90° arcs on the uphill, downhill, left, and right sides, and directly overhead (modified from Vonhof and Barclay 1997).

Miscellaneous Category.—For conifer snags and stumps, we used a clinometer to estimate the slope and a compass to estimate the aspect on which roost or random structures were located. Elevation was obtained using GIS and GPS. We used GIS and aerial photographs to measure the distance the used or random structure was from the nearest road for conifer snags only, and to the capture site, available water, and the edge of the stand for conifer snags and stumps.

Statistical Analyses

To analyze characteristics of conifer snags and stumps used as day-roosts, we pooled data from bats instrumented over both years of the study, a Design 2 approach from Thomas and Taylor (1990). We excluded data collected from 3 stumps of trees >100 years of age and 1 burned out snag in a clearcut from these analyses because these types of structures were used infrequently and differed in many respects from stumps or snags typically used as day-roosts. One snag that was used during both years of this study was counted as a single roost for statistical purposes.

We used Fisher's exact test (PROC FREQ; SAS Institute 1990) to compare relative use of types of roosts (conifer trees and snags, conifer stumps, and hardwood trees and snags) between watershed types. Fisher's exact test is appropriate to use to test for differences in frequencies when cell counts are <5 (Ramsey and Schafer 1997, Steel et al. 1997). Data from Little Fall Creek and the South McKenzie watersheds were combined for this analysis because of similarities in forest conditions. We also used Fisher's exact test to compare selection of roosts (conifer stumps, conifer and hardwood trees and snags, and both types of structures) among reproductive conditions (pregnant, lactating, post-lactating, and non-parous) of 21 female long-eared myotis; energy demands associated with reproductive status of bats may influence selection of day-roosts (Kunz 1982, Campbell et al. 1996, Vonhof and Barclay 1996, Betts 1998, Crampton and Barclay 1998, Ormsbee and McComb 1998). We used Fisher's exact test to compare age of stands (<36, 36–80, and >80 yr old) for day-roosts and random points for each capture site and for the entire study area. We tested for differences in distances of day-roosts and random points from available water and from capture sites using the Mann-Whitney *U*-test.

We used stepwise logistic regression (PROC GENMOD; SAS Institute 1997) to compare characteristics of day-roosts and randomly available structures, and to test for differences in patterns of use among watersheds and capture sites. We conducted logistic regression analyses for structural, plot, and miscellaneous categories, and for all categories combined; analyses were conducted for conifer snags and stumps separately. Variables were included in the models at $P = 0.05$. Odds ratios were calculated by taking the antilogarithm of the parameter estimate (Ramsey and Schafer 1997); examples of calculations for odds ratios are presented in the results.

Table 1. Number of roost structures used by female long-eared myotis ($n = 21$) in watersheds generally characterized by older forests (Fall Creek) and younger forests (Little Fall Creek and South McKenzie River) in the Cascade Range of western Oregon, 1996 and 1997.

Structure	Watershed: Fall Creek	Watershed: Little Fall Creek and South McKenzie River	Total
Conifer stump	14	27	41
Conifer snag	19	2	21
Conifer tree	3	0	3
Hardwood tree	1	5	6
Conifer log	1	1	2
Overall	38	35	73

RESULTS

We identified 73 different roost structures used by 21 female long-eared myotis on 102 occasions (Table 1); 1 snag was used during both years of this study. Individual females were located 4.9 ± 0.5 (SE) occasions (range = 1–11) with an average of 3.5 ± 0.4 roosts identified for each female (range = 1–8). Female long-eared myotis remained in individual roosts an average of 1.2 ± 0.1 days (range = 1–4).

Reproductive condition of bats did not significantly influence the type of structure used ($n = 4$ pregnant, 9 lactating, 6 post-lactating, and 2 non-parous females; $P = 0.383$), and individual bats often used more than 1 type of roost structure. Frequency of use of different types of roost structures differed between watershed types ($P < 0.001$); female long-eared myotis primarily roosted in conifer stumps in watersheds generally characterized by younger forests (Little Fall Creek and South McKenzie River) and roosted primarily in conifer snags in landscapes generally characterized by older forests (Fall Creek; Table 1). Type of roost structure used was also related to age of stand; 23 of the 24 conifer snags and trees ($n = 20$ snags and 3 trees) used as day-roosts were in stands ≥36 years old, whereas all used conifer stumps ($n = 41$) and logs ($n = 2$) were in stands <36 years old. At 3 capture sites, female long-eared myotis disproportionately roosted in stands <36 years old ($P < 0.01$; Table 2). A similar pattern was observed at another capture site, although this difference was not statistically significant. Female long-eared myotis only used stands ≥36

Table 2. Observed and expected frequencies (Fisher's exact test) of day-roosts of female long-eared myotis (all roost types combined) by stand age within 2.4 km of each capture site in the Cascade Range of western Oregon, 1996 and 1997. Expected values are based on the proportion of 50 points that were located in stands of each age class.

	Stand age (yr)						
	<36		36 to 80		>80		
Site	Used	Expected	Used	Expected	Used	Expected	P
B1828[a]	11	16.5	14	9.4	10	9.1	0.30
B1833[a]	4	0.9	0	1.8	0	1.3	0.002
LFC[b]	4	1.7	1	3.3	0	0	0.43
Coopers[c]	15	6.6	0	4.3	2	6.1	<0.001
Wader[c]	13	8.4	0	4.5	0	0	0.002
Combined	47	31.5	15	27.9	12	14.6	<0.001

[a] Fall Creek watershed.
[b] Little Fall Creek watershed.
[c] South McKenzie River area.

years old for roosting more frequently than the relative proportion available at 1 capture site, but this difference was not statistically significant (P = 0.30; Table 2).

Day-roosts generally were located in upslope habitats, with only 2 roosts (1 conifer tree and 1 conifer snag) occurring within 100 m of large streams. Day-roosts (n = 73) averaged 0.59 ± 0.03 km from available water and 0.66 ± 0.02 km from capture sites. Day-roosts were not significantly closer than random points to available water (P = 0.727), but were significantly closer than random points to capture sites (P < 0.001).

Conifer Snags

Conifer snags used as day-roosts (n = 20) averaged 472 ± 20 m in elevation, 0.62 ± 0.04 km from capture sites, 0.52 ± 0.05 km from available water, 34 ± 5 m in height, 93 ± 12 cm dbh, and retained 82.7 ± 5.2% of the bark. Roosts generally did not protrude above the surrounding forest canopy, and 90% of the roosts extended into the upper canopy (45%), occurred in a gap (65%), or were located within 25 m of the edge of a stand (20%). Eighteen roosts had broken tops. Most snags used as roosts were Douglas-fir (n = 18), and 2 were western hemlock. Most snags were in intermediate stages of decay (class 2; n = 13), although structures in class 1 (n = 5) and 3 (n = 2) were also used.

Snags in decay classes 1 and 2 were 1.7 (odds = exp[0.549] = 1.7; 95% CI = 0.3–14.0) and 29.3 (95% CI = 4.3–343.1) times more likely to be selected as day-roosts than structures in decay class 3, respectively (Table 3). Additionally, odds of use increased with number of snags in decay class 2 within 20 m. After accounting for the watershed in which the structure was located, a conifer snag with 7.4 snags within 20 m ($2 \times \bar{x}$) was 4.5 times more likely to be used than a snag having 3.7 snags within 20 m (7.4

Table 3. Parameters and estimates (ln scale) resulting from logistic regression analysis of 24 random and 20 conifer snags used as day-roosts by female long-eared myotis in the Cascade Range of western Oregon, 1996 to 1997.

Category	Parameter	df	P	Estimate	95% CI	Odds ratio
Structural[a]	Intercept	1		−1.50	−3.39 to −0.15	0.22
	Decay class	2	0.0002			
	1	1		0.55	−1.22 to 2.64	1.73
	2	1		3.38	1.45 to 5.84	29.25
	3	0				
Plot	Intercept	1		−2.99	−6.29 to −0.81	0.05
	Watershed	1	0.0412			
	Fall Creek	1		2.15	0.08 to 5.14	8.61
	S. McKenzie	0				
	No. of snags[b]	1	0.0024	0.41	0.13 to 0.77	1.51
Miscellaneous	Intercept	1		0.62	−0.29 to 1.61	1.86
	Distance[c]	1	0.0192	−3.06	−6.53 to −0.45	0.05

[a] Models for structure and combined categories were the same. The combined category was derived from a stepwise analysis using all variables.
[b] Number of snags in decay class 2.
[c] Distance to the edge of the stand (km).

Table 4. Parameters and estimates (ln scale) resulting from logistic regression analysis of 54 random and 38 conifer stumps used as day-roosts by female long-eared myotis in the Cascade Range of western Oregon, 1996 to 1997.

Category	Parameter	df	*P*	Estimate	95% CI	Odds ratio
Structure	Intercept	1		−6.77	−10.44 to −3.89	0.001
	Species	2	0.0159			
	Douglas-fir	1		3.01	0.90 to 5.58	20.37
	W. hemlock	1		2.19	0.31 to 4.51	8.97
	W. redcedar	0				
	Downhill height	1	0.0440	0.01	0.0003 to 0.02	1.01
	Crevices[a]	1	0.0001	0.17	0.09 to 0.27	1.19
	Crevices × crevices[a]	1	0.0065	−0.001	−0.002 to −0.0004	0.999
Plot	Intercept	1		−2.40	−4.19 to −0.97	0.09
	% access at 5 m	1	0.0001	0.03	0.02 to 0.06	1.03
	Wood[b]	1	0.0190	−0.36	−0.69 to −0.06	0.70
Miscellaneous	Intercept	1		−2.08	−3.70 to −0.63	0.13
	Slope	1	0.0132	0.03	0.006 to 0.05	1.03
Combined[c]	Intercept	1		−17.88	−28.21 to −10.60	<0.001
	Species	2	0.0607			
	Douglas-fir	1		3.65	0.54 to 7.88	38.36
	W. hemlock	1		2.81	−0.13 to 6.82	16.59
	W. redcedar	0				
	Crevices[a]	1	0.0001	0.23	0.13 to 0.37	1.26
	Crevices × crevices[a]	1	0.0017	−0.002	−0.003 to −0.0007	0.998
	% access at 5 m	1	0.0021	0.05	0.02 to 0.08	1.055
	Slope	1	0.0002	0.08	0.04 to 0.14	1.09
	Wood[b]	1	0.0010	−0.79	−1.40 to −0.30	0.45
	Capture site	3	0.0260			
	B1828[d]	1		3.31	0.73 to 6.42	27.50
	Wader[e]	1		3.57	0.82 to 6.84	35.33
	Coopers[e]	1		4.25	1.28 to 7.91	70.39
	B1833[d]	0				

[a] Percent of stump circumference that has crevices that bats could use as roosts.
[b] Pieces of wood (all sizes) within 1 m of the stump.
[c] The combined category was derived from a stepwise analysis using all variables.
[d] Fall Creek watershed.
[e] South McKenzie River area.

− 3.7 = 3.7, odds = exp[0.4094]$^{3.7}$ = 4.5; 95% CI = 1.6 to 17.2; Table 3). Furthermore, odds of a conifer snag being selected as a day-roost decreased with increasing distance from the edge of a stand; a snag located 0.186 km (mean) from stand edge was 1.8 times (95% CI = 1.1–3.4) more likely to be used than one located twice that distance (Table 3).

Conifer Stumps

Conifer stumps used as day-roosts (n = 38) averaged 667 ± 25 m in elevation, 0.73 ± 0.03 km from capture sites, 0.71 ± 0.04 km from available water, 59 ± 6 cm in height on the uphill side, 133 ± 9 cm in height on the downhill side, and 59 ± 4 cm in diameter. Western hemlock (n = 23) and Douglas-fir (n = 13) were used most commonly; western redcedar was used on 2 occasions. On average, openings to crevices in which bats roosted were 102 ± 7 cm above the ground, 49 ± 4 cm deep, and 17 ± 1 cm wide.

After accounting for percentage of potential crevices on a stump and downhill height of the stump, female long-eared myotis were 20.4 times (95% CI = 2.5–265.1) more likely to use Douglas-fir stumps and 9.0 times (95% CI = 1.4–90.5) more likely to use western hemlock stumps as western redcedar stumps (Table 4). Conversely, after accounting for species of stump and percentage of potential crevices, a stump that was 266.8 cm in height on the downhill side (2× mean) was 3.6 times more likely to be used (95% CI = 1.0–14.6) than a stump 133.4 cm in height on the downhill side. Conifer stumps that were 85.5% accessible (mean access) were 4.3 times more likely to be used (95% CI = 2.0–10.8) than stumps that were 42.75% accessible, after accounting for woody debris within 1 m of the stump (Table 4). Furthermore, stumps located on a 66.3% slope (mean slope) were 2.5 times more likely to be used (95% CI = 1.2–5.7) than stumps on a 33.15% slope (Table 4).

DISCUSSION

Female long-eared myotis used several different types of structures as day-roosts. This result is consistent with previous observations for long-eared myotis (Manning and Jones 1989; Christy and West 1993; Vonhof and Barclay 1996, 1997; Rabe et al. 1998). The variety of roost types used by long-eared myotis appears to exceed that for several other species of bats in the Pacific Northwest (Campbell et al. 1996, Vonhof and Barclay 1996, Brigham et al. 1997, Betts 1998, Ormsbee and McComb 1998). Use of multiple types of roosts by long-eared myotis may enable individuals to adjust to availability of different types of structures in a landscape. Long-eared myotis inhabiting areas with low densities of large conifer snags, may use other types of structures (e.g., stumps and logs) as day-roosts rather than compete with other species for roost sites in the few remaining large conifer snags.

Use of snags in early and intermediate stages of decay by several species of bats (Campbell et al. 1996, Vonhof and Barclay 1996, Brigham et al. 1997, Betts 1998, Ormsbee and McComb 1998) is probably related to roosting opportunities under exfoliating bark or in woodpecker cavities within these structures. Snags in early stages of decay generally provide fewer crevices or cavities for roosting, whereas snags in advanced stages of decay lose potential roost crevices and cavities due to sloughing of exfoliating bark and the bole breaking at or below cavities.

Conifer trees and snags that extend above the surrounding canopy have been hypothesized to provide preferred roost sites for bats by providing increased solar radiation, navigational cues, and increased access (Campbell et al. 1996, Vonhof and Barclay 1996, Brigham et al. 1997, Callahan et al. 1997, Betts 1998, Ormsbee and McComb 1998). Snags receiving high levels of solar radiation acquire more heat than those shaded for a major portion of the day (Geiger 1957). This increased warmth may benefit bats by facilitating development of fetuses or juveniles and by minimizing energetic demands of reproductive females (Campbell et al. 1996, Vonhof and Barclay 1996, Brigham et al. 1997, Betts 1998, Kalcounis and Brigham 1998, Ormsbee and McComb 1998). Several studies have documented that forest-dwelling bats in the Pacific Northwest often use large diameter snags that protrude above the forest canopy (Campbell et al. 1996, Vonhof and Barclay 1996, Brigham et al. 1997, Betts 1998, Ormsbee and McComb 1998). Although we did not observe any tendency for female long-eared myotis to preferentially select snags protruding above the canopy, we did observe substantial use of snags in canopy gaps and some use of snags on edges of stands. Conifer snags located near edges of stands or in canopy gaps, may offer many of the same benefits as snags that extend above the canopy. In addition to the thermal benefits and accessibility of roosts in gaps and on edges, the use of gaps and edges by bats for foraging and commuting (Furlonger et al. 1987, Crome and Richards 1988, Grindal and Brigham 1998) may increase the likelihood of bats roosting in these areas.

Although conifer stumps provide important roosting habitat for long-eared myotis, suitability of stumps as roost sites may be restricted to a narrow window of time because of the combined effects of stand development in recently harvested stands, the phenology of decay processes in stumps, and seasonal environmental conditions. Access to a stump appears to be particularly important in determining its suitability as a day-roost (Vonhof and Barclay 1997). Because of the importance of accessibility, roosting opportunities in most stumps are highly ephemeral, as shrubs and young trees in recently harvested stands cover most stumps in a relatively short period of time. Our observations suggest that the length of time a stump is accessible to bats for roosting is often limited to approximately 10–15 years from the time it was cut. Tall stumps, and stumps located on steep ground, in gaps, or in stands with minimal vegetation may remain accessible to bats for longer periods. Additionally, bark of newly cut stumps generally does not exfoliate sufficiently to form crevices in which bats can roost. Our observations suggest that crevices adequate for roosting often do not form for several years after a tree has been cut. Consequently, there is typically a limited number of years during which stumps with adequate crevices can be effectively used as roosts by bats. This period may often be 5 years, but will vary with the age of the stand that was cut, site condition, density of seedlings, methods of harvest and site preparation, and other factors. Furthermore, use of conifer stumps as day-roosts by bats may be limited to summers when stumps are dry; crevices in stumps in our study area were often wet or filled with snow during the spring, fall, and winter.

Although Vonhof and Barclay (1997) suggested that use of conifer stumps as day-roosts by long-eared myotis may be limited to males or nonreproductive females, we documented both reproductive and nonreproductive females using stumps as day-roosts. In addition, we have observed males and juveniles of both sexes using stumps (D. L. Waldien, Oregon State University, unpublished data). Although we generally observed solitary long-eared myotis using stumps, small maternity colonies (up to 14 bats) have been observed in stumps (D. L. Waldien, Oregon State University, unpublished data).

Our observation that long-eared myotis do not preferentially roost closer to water is consistent with observations for silver-haired bats (Betts 1998) and long-legged myotis (*Myotis volans*; Ormsbee and McComb 1998). Use of roosts in upslope habitats may be beneficial to bats, as roosts in upslope habitats may be warmer than those in riparian areas (Campbell et al. 1996). However, water is an important resource to bats and research has shown that foraging areas are often near open water (Lunde and Harestad 1986, Thomas 1988, Barclay 1991, Brigham et al. 1992, Adams 1997, Waldien 1998). We caution that better understanding of the spatial relationships between day-roosts and water is generally hindered by methodological constraints and the spatial scale used for analysis in this study.

Our results demonstrate that selection of study areas and capture sites can strongly influence inferences drawn from evaluations of habitat relationships. Our conclusions would have differed dramatically had we restricted our research either to intensively managed landscapes characterized by younger seral forests or to lands with more older forests. Thus, we urge caution when interpreting results from studies limited in the range of habitat conditions represented around a capture site. However, in light of other research on long-eared myotis and other species of forest-dwelling bats in similar habitats, we suspect use of large conifer snags and stumps as day-roosts is typical of long-eared myotis in western coniferous forests. We suggest that future research on roost selection by bats incorporate landscape variation and availability of roost structures in the study design.

MANAGEMENT IMPLICATIONS

Retention and recruitment of snags in managed forests is an important consideration for the conservation and management of forest-dwelling bats (Campbell et al. 1996, Brigham et al. 1997). Our results suggest that large-diameter conifer snags provide primary roosting habitat for long-eared myotis when these structures are present in the landscape. This finding is consistent with previous results on roost selection of several species of forest-dwelling bats (Campbell 1996, Vonhof and Barclay 1996, Brigham et al. 1997, Betts 1998, Ormsbee and McComb 1998, Rabe et al. 1998). We recommend that management efforts for bats in western coniferous forests focus on maintaining large conifer snags in early and middle stages of decay throughout the landscape. We suggest that management of snags for bats should focus on maintaining structures that are easily accessible to bats or have moderate to high levels of exposure to solar radiation (e.g., snags protruding above the surrounding canopy, in canopy gaps, and near edges adjacent to clearings), which may help provide optimum microhabitat in the roost. Thinning densely stocked forest stands can be used both to accelerate the development of large-diameter roost structures (Hayes et al. 1997), and to create gaps and increase levels of solar radiation for individual structures. Locating potential day-roost sites near locations where bats may access sources of water (Waldien 1998) and night-roosts (Ormsbee and McComb 1998, Adam and Hayes 2000) is likely to increase the quality and use of a roost. Our data also suggest that retaining snags in clusters may be beneficial for long-eared myotis.

Green-tree retention and snag creation offer managers opportunities to provide future roost structures for bats. Green-tree retention should emphasize large trees as they generally persist for long periods of time and are used extensively by many species of bats (Campbell et al. 1996, Vonhof and Barclay 1996, Brigham et al. 1997, Betts 1998, Ormsbee and McComb 1998, Rabe et al. 1998) and other species of wildlife (Cline et al. 1980, Raphael and Morrison 1987, Machmer and Steeger 1995, Bull et al. 1997, Weikel and Hayes 1999). Snags can be created by various means (Carey and Sanderson 1981, Conner et al. 1981, Bull and Partridge 1986, Lewis 1998), although there may be a time lag during which there are limited opportunities for bats to roost in created snags until woodpeckers excavate cavities or bark exfoliates sufficiently to provide crevices.

Studies have shown that availability of snags is generally lower in young stands on managed landscapes than in older stands (Ohmann et al. 1994). Use of snags as day-roosts primarily occurs in older forest stands (Campbell et al. 1996, Vonhof and Barclay 1996, Brigham et al. 1997, Betts 1998, Ormsbee and McComb 1998) whereas the use of snags as day-roosts in clearcuts and young stands by long-eared myotis and several other species of bats appears to less common. Therefore, maintaining remnant patches of structurally diverse, commonly older, forests with large snags in watersheds may be important for bats in intensively managed landscapes. Diverse vegetative structure within forest patches, even <1 ha in size, can have a positive influence on species richness and supports the value of maintaining structurally diverse patches of forest in managed landscapes (Bunnell et al. 1999). Roost structures located in isolated patches of remnant older forest receive more use than roosts in contiguous forests, although roosts are generally more abundant in contiguous forests in some forest ecosystems (Zielinski and Gellman 1999). Bat communities inhabiting intensively managed landscapes will likely benefit from the maintenance or creation of snags in recent clearcuts and young stands, and maintaining remnant patches of older forests.

In landscapes where there are relatively few large conifer snags, stumps appear to provide important roost sites for long-eared myotis. Managed forests will likely provide a continual supply of stumps that may be suitable for roosting, and the importance of this type of structure should not be discounted when considering management of habitat for long-eared myotis. Use of stumps increases when surrounding vegetation does not obstruct the structure. Thus, managing vegetation around stumps (Vonhof and Barclay 1997) or for stumps located in natural openings and on steeper slopes may prolong their availability to long-eared myotis. Creating tall conifer stumps during harvest operations, including topping trees by ground-based harvesting equipment (Lewis 1998), may also prolong the availability and use of these structures as vegetation grows around them. We caution that use of stumps by bats is likely ephemeral and is primarily known for long-eared myotis with limited observations of use by 3 other species of bats (Vonhof and Barclay 1997; D. L. Waldien, Oregon State University, unpublished data), and thus stumps probably provide limited roosting opportunities for most species of bats.

ACKNOWLEDGMENTS

We thank R. G. Anthony, W. H. Emmingham, S. Hobbs, T. Righetti, and 2 anonymous reviewers for reviewing earlier drafts of this manuscript. J. R. Faulkner, J. C. Gruver, C. Oxley, B. Rinehart, R. Schifferdecker, C. Smith, G. Smith, M. Souza, B. Stanfield, and B. E. Wright provided valuable field assistance. M. M. P. Huso and L. M. Ganio provided statistical advice; C. Berry provided GIS support. This study was funded by Bat Conservation International, Eugene District of the Bureau of Land Management, Forest and Rangeland Ecosystem Science Center, Oregon Chapter of The Wildlife Society, Oregon Department of Fish and Wildlife, Oregon State University Department of Forest Science, U.S. Army Corps of Engineers (Willamette Valley Project), U.S. Fish and Wildlife Service, Weyerhaeuser Company, Willamette Industries, and the Willamette National Forest.

LITERATURE CITED

ADAM, M. D., AND J. P. HAYES. 2000. Use of bridges as night roosts by bats in the Oregon Coast Range. Journal of Mammalogy 80:In Press.

———, M. J. LACKI, AND T. G. BARNES. 1994. Foraging areas and habitat use of the Virginia big-eared bat in Kentucky. Journal of Wildlife Management 58:462–469.

ADAMS, R. A. 1997. Onset of volancy and foraging patterns of juvenile little brown bats, *Myotis lucifugus*. Journal of Mammalogy 78:239–246.

ALDRIDGE, H. D. J. N., AND R. M. BRIGHAM. 1988. Load carrying and maneuverability in an insectivorous bat: a test of the 5% "rule" of radio-telemetry. Journal of Mammalogy 69:379–382.

ANTHONY, E. L. P. 1988. Age determination in bats. Pages 47–58 *in* T. H. Kunz, editor. Ecological and behavioral methods for the study of bats. Smithsonian Institution Press, Washington, D.C., USA.

BARCLAY, R. M. R. 1991. Population structure of temperate zone insectivorous bats in relation to foraging behaviour and energy demand. Journal of Animal Ecology 60:165–178.

———, P. A. FAURE, AND D. R. FARR. 1988. Roosting behavior and roost selection by migrating silver-haired bats (*Lasionycteris noctivagans*). Journal of Mammalogy 69:821–825.

BETTS, B. J. 1998. Roosts used by maternity colonies of silver-haired bats in northeastern Oregon. Journal of Mammalogy 79:643–650.

BOGAN, M. A. 1999. Long-eared myotis/*Myotis evotis*. Pages 88–90 *in* D. E. Wilson and S. Ruff, editors. The Smithsonian book of North American mammals. Smithsonian Institution Press, Washington, D.C., USA.

BRIGHAM, R. M. 1991. Flexibility in foraging and roosting behaviour by the big brown bat (*Eptesicus fuscus*). Canadian Journal of Zoology 69:117–121.

———, H. D. J. N. ALDRIDGE, AND R. L. MACKEY. 1992. Variation in habitat use and prey selection by Yuma bats, *Myotis yumanensis*. Journal of Mammalogy 73:640–645.

———, AND R. M. R. BARCLAY. 1996. Bats and forests: conference summary. Pages xi-xiv *in* R. M. R. Barclay and R. M. Brigham, editors. Bats and forests symposium. British Columbia Ministry of Forests, Victoria, British Columbia, Canada.

———, M. J. VONHOF, R. M. R. BARCLAY, AND J. C. GWILLIAM. 1997. Roosting behavior and roost-site preferences of forest-dwelling California bats (*Myotis californicus*). Journal of Mammalogy 78: 1231–1239.

BULL, E. L., AND A. D. PARTRIDGE. 1986. Methods of killing trees for use by cavity nesters. Wildlife Society Bulletin 14:142–146.

———, C. G. PARKS, AND T. R. TORGERSEN. 1997. Trees and logs important to wildlife in the interior Columbia River Basin. U.S. Forest Service General Technical Report PNW-GTR-391.

BUNNELL, F. L., R. W. WELLS, J. D. NELSON, AND L. L. KREMASTER. 1999. Patch sizes, vertebrates, and effects of harvest policy in southeastern British Columbia. Pages 271–293 *in* J. A. Rochelle, L. A. Lehmann, and J. Wisniewski, editors. Forest fragmentation: wildlife and management implications. Brill, Leiden, The Netherlands.

CAIRE, W., J. F. SMITH, S. MCGUIRE, AND M. A. ROYCE. 1984. Early foraging behavior of insectivorous bats in western Oklahoma. Journal of Mammalogy 65:319–324.

CALLAHAN, E. V., R. D. DROBNEY, AND R. L. CLAWSON. 1997. Selection of summer roosting sites by Indiana bats (*Myotis sodalis*) in Missouri. Journal of Mammalogy 78:818–825.

CAMPBELL, L. A., J. G. HALLET, AND M. A. O'CONNELL. 1996. Conservation of bats in managed forests: use of roosts by *Lasionycteris noctivagans*. Journal of Mammalogy 77:976–984.

CAREY, A. B., AND H. R. SANDERSON. 1981. Routing to accelerate tree-cavity formation. Wildlife Society Bulletin 9:14–21.

CHRISTY, R. E., AND S. D. WEST. 1993. Biology of bats in Douglas-fir forests. U.S. Forest Service General Technical Report PNW-GTR-308.

CLINE, S. P., A. B. BERG, AND H. M. WIGHT. 1980. Snag characteristics and dynamics in Douglas-fir forests, western Oregon. Journal of Wildlife Management 44:773–786.

CONNER, R. N., J. G. DICKSON, AND B. A. LOCKE. 1981. Herbicide-killed trees infected by fungi: potential cavity sites for woodpeckers. Wildlife Society Bulletin 9:308–310.

CRAMPTON, L. H., AND R. M. R. BARCLAY. 1998. Selection of roosting and foraging habitat by bats in different-aged aspen mixedwood stands. Conservation Biology 12:1347–1358.

CROME, F. J. H., AND G. C. RICHARDS. 1988. Bats and gaps: microchiropteran community structure in a Queensland rain forest. Ecology 69:1960–1969.

FOREST ECOSYSTEM MANAGEMENT ASSESSMENT TEAM. 1993. Forest ecosystem management: an ecological, economic, and social assessment: report of the Forest Ecosystem Management Team. U.S. Forest Service, Washington, D.C., USA.

FRANKLIN, J. F., AND C. T. DYRNESS. 1973. Natural vegetation of Oregon and Washington. Oregon State University Press, Corvallis, Oregon, USA.

FURLONGER, C. L., H. J. DEWAR, AND M. B. FENTON. 1987. Habitat use by foraging insectivorous bats. Canadian Journal of Zoology 65:284–288.

GEIGER, R. 1957. The climate near the ground. Harvard University Press, Cambridge, Massachusetts, USA.

GRINDAL, S. D., AND R. M. BRIGHAM. 1998. Short term effects of small-scale habitat disturbance on activity by insectivorous bats. Journal of Wildlife Management 62:996–1003.

HAYES, J. P., S. S. CHAN, W. H. EMMINGHAM, J. C. TAPPEINER, L. D. KELLOGG, AND J. D. BAILEY. 1997. Wildlife response to thinning young forests in the Pacific Northwest. Journal of Forestry 95: 28–33.

JUNG, T. S., AND I. D. THOMPSON, R. D. TITMAN, AND A. P. APPLEJOHN. 1999. Habitat selection by forest bats in relation to mixed-wood stand types and structure in central Ontario. Journal of Wildlife Management 63:1306–1319.

KALCOUNIS, M. C., AND R. M. BRIGHAM. 1998. Secondary use of aspen cavities by tree-roosting big brown bats. Journal of Wildlife Management 62: 603–611.

KUNZ, T. H. 1982. Roosting ecology of bats. Pages 1–55 *in* T. H. Kunz, editor. Ecology of bats. Plenum Press, New York, USA.

———, AND A. KURTA. 1988. Capture methods and holding devices. Pages 1–29 *in* T. H. Kunz, editor. Ecological and behavioral methods for the study of bats. Smithsonian Institution Press, Washington, D.C., USA.

KURTA, A., G. P. BELL, K. A. NAGY, AND T. H. KUNZ. 1989. Energetics of pregnancy and lactation in free-ranging little brown bats (*Myotis lucifugus*). Physiological Zoology 62:804–818.

LEWIS, J. C. 1998. Creating snags and wildlife trees in commercial forest landscapes. Western Journal of Applied Forestry 13:97–101.

LORENSEN, T., C. ANDRUS, AND J. RUNYON. 1994. The Oregon forest practices act water protection rules: scientific and policy considerations. Oregon Department of Forestry, Salem, Oregon, USA.

LUNDE, R. E., AND A. S. HARESTAD. 1986. Activity of little brown bats in coastal forests. Northwest Science 60:206–209.

MACHMER, M. M., AND C. STEEGER. 1995. The ecological roles of wildlife tree users in forest ecosystems. British Columbia Ministry of Forests, Victoria, British Columbia, Canada.

MANNING, R. W., AND J. K. JONES, JR. 1989. *Myotis evotis*. Mammalian Species 329.

MARSHALL, D. B., M. W. CHILCOTE, AND H. WEEKS. 1996. Species at risk: sensitive, threatened and endangered vertebrates of Oregon. Second edition. Oregon Department of Fish and Wildlife, Portland, Oregon, USA.

MATTSON, T. A., S. W. BUSKIRK, AND N. L. STANTON. 1996. Roost sites of the silver-haired bat (*Lasionycteris noctivagans*) in the Black Hills, South Dakota. Great Basin Naturalist 56:247–253.

OHMANN, J. L., W. C. MCCOMB, AND A. A. ZUMRAWI. 1994. Snag abundance for primary cavity-nesting birds on nonfederal lands in Oregon and Washington. Wildlife Society Bulletin 22:607–620.

ORMSBEE, P. C., AND W. C. MCCOMB. 1998. Selection of day roosts by female long-legged myotis in the central Oregon Cascade Range. Journal of Wildlife Management 62:596–603.

RABE, M. J., T. E. MORRELL, H. GREEN, J. C. DEVOS, JR., AND C. R. MILLER. 1998. Characteristics of ponderosa pine snag roosts used by reproductive bats in northern Arizona. Journal of Wildlife Management 62:612–621.

RACEY, P. A. 1988. Reproductive assessment in bats. Pages 31–46 *in* T. H. Kunz, editor. Ecological and behavioral methods for the study of bats. Smithsonian Institution Press, Washington, D.C., USA.

RAMSEY, F. L. AND D. W. SCHAFER. 1997: The statistical sleuth: a course in methods of data analysis. Duxbury Press, Belmont, California, USA.

RAPHAEL, M. G., AND M. L. MORRISON. 1987. Decay and dynamics of snags in the Sierra Nevada, California. Forest Science 33:774–783.

SAS INSTITUTE INC. 1990. SAS/STAT® user's guide. Version 6. Fourth edition. Volume 1. SAS Institute, Cary, North Carolina, USA.

———, 1997. SAS/STAT® software: changes and enhancements through Release 6.12. SAS Institute, Cary, North Carolina, USA.

STEEL, R. G. D., J. H. TORRIE, AND D. A. DICKEY. 1997. Principles and procedures of statistics: a biometrical approach. Third edition. McGraw-Hill, New York, New York, USA

THOMAS, D. L., AND E. J. TAYLOR. 1990. Study designs and tests for comparing resource use and availability. Journal of Wildlife Management 54: 322–330.

THOMAS D. W. 1988. The distribution of bats in different ages of Douglas-fir forests. Journal of Wildlife Management 52:619–626.

TUTTLE, M. D. 1976. Population ecology of the gray bat (*Myotis grisescens*): factors influencing growth and survival of newly volent young. Ecology 57:587–595.

U.S. FOREST SERVICE AND U.S. BUREAU OF LAND MANAGEMENT. 1994. Record of decision for amendments to Forest Service and Bureau of Land Management planning documents within the range of the northern spotted owl. Standards and guidelines for management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl. U.S. Forest Service and U.S. Bureau of Land Management, Portland, Oregon, USA.

VERTS, B. J., AND L. N. CARRAWAY. 1998. Land mammals of Oregon. University of California Press, Berkeley, California, USA.

VONHOF, M. J., AND R. M. R. BARCLAY. 1996. Roost-site selection and roosting ecology of forest-dwelling bats in southern British Columbia. Canadian Journal of Zoology 74:1797–1805.

———, AND R. M. R. BARCLAY. 1997. Use of tree stumps as roosts by the western long-eared bat. Journal of Wildlife Management 61:674–684.

WALDIEN, D. L. 1998. Characteristics and spatial relationships of day-roosts and activity areas of female long-eared myotis (*Myotis evotis*) in western Oregon. Thesis, Oregon State University, Corvallis, Oregon, USA.

———, AND J. P. HAYES. 1999. A technique to capture bats using hand-held mist nets. Wildlife Society Bulletin 27:197–200.

WEIKEL, J. M., AND J. P. HAYES. 1999. The foraging ecology of cavity-nesting birds in young forests of the northern Coast Range of Oregon. Condor 101:58–66.

WETHINGTON, T. A., D. M. LESLIE, JR., M. S. GREGORY, AND M. K. WETHINGTON. 1996. Prehibernation habitat use and foraging activity by endangered Ozark big-eared bats (*Plecotus townsendii ingens*). American Midland Naturalist 135:218–230.

ZIELINSKI, W. J., AND S. T. GELLMAN. 1999. Bat use of remnant old-growth redwood stands. Conservation Biology 13:160–167.

Received 29 April 1999.
Accepted 18 January 2000.
Associate Editor Sullivan.